United States Environmental Protection Agency
Office of Air and Radiation 6202J
EPA 430-B-97-002 January 1997

Business Analysis for Energy-Efficiency Investments

All organizations employ basic financial analysis tools to examine the value, risk, and liquidity impacts of investment opportunities competing for limited capital resources. To successfully compete against other business investments, energy-efficiency projects need to be evaluated using the same tools. Fortunately, an informed decision can be facilitated by understanding several basic financing concepts, and applying several basic tools. This document explains the tools necessary to evaluate profitability, cash flow, and liquidity, and presents a framework for using these tools to analyze building upgrade investments that are consistent with the EPA ENERGY STAR Buildings Program's guidelines. ☆

Capital Budgeting Basics

Both for-profit and not-for-profit organizations evaluate potential investments based on their financial bottom line. To evaluate this bottom line, financial analyses look at whether an investment passes a hurdle rate while maintaining acceptable first cost and liquidity requirements. Profitability is typically measured by whether the project's internal rate of return passes a hurdle rate, and cash flow and liquidity are evaluated by first cost and payback.

- *Internal Rate of Return* (IRR) is the interest rate that equates the present value of expected future cash flows to the initial cost of the project. Expressed as a percentage, IRR is easily compared with loan or hurdle rates to determine an investment's profitability. For example, assume that a project is financed with a loan at 12 percent interest. If the IRR for the project exceeds 12 percent, then the company can invest in the project, use the cash flow to pay off the loan principal and interest, and still have a surplus as profit.
- *Hurdle rate* is the accept/reject criteria for determining if an investment passes the profitability test. If the IRR is higher than the hurdle rate, the investment is profitable. Hurdle rates are the marginal cost of capital, adjusted for a project's risk. The higher the cost of capital and risk, the higher the hurdle rate. EPA ENERGY STAR Buildings Program recommends using a 20 percent hurdle rate for energy-efficiency investments.
- *First cost* is the upfront cost that is incurred before the investment generates any savings. Large first costs put stress on the balance sheet and may cause an investment to be rejected even if it is profitable in the long run.
- *Simple payback* is the number of years required to return the original investment from net cash flows. Payback is an indicator of liquidity because it measures the speed with which an investment can be converted into cash. Payback is also used as an indicator of risk. As a general rule, short-term events can be predicted more precisely than events in the distant future, so projects that have a short payback period are generally considered less risky, if everything else is constant.

Payback cannot be used as an indicator of profitability because it does not consider returns beyond the payback period and it ignores the time value of money. IRR can be found for each combination of payback and time horizon if we assume the first cost is made in a single payment in year zero and the savings in future years are uniform. Thus, with knowledge of the payback and time horizon we know whether a project passes the profitability test. See the Payback/IRR table in the appendix. ☆

Capital Budgeting Glossary

Cost of capital	The discount rate that is used in the capital budgeting process.
Discount rate	The interest rate used to discount future revenue streams.
Hurdle rate	The minimum acceptable internal rate of return for a project.
Internal rate of return	The interest rate that equates the present value of expected future cash flows to the initial cost of the project.
Net present value	The present value of the expected net cash flows of an investment, discounted at an appropriate percentage rate, minus the initial cost outlay of the project.
Simple payback	The number of years required to return the original investment from net cash flows.
Time value of money	Money received today is valued more highly than money received at a future date.

Cash Flow Assumptions

Estimating cash flow is the most difficult part of the financial analysis. For energy-efficiency investments, you must consider initial retrofitting costs, energy savings over the life of the equipment, and operation and maintenance costs. Initial retrofitting costs are relatively easy to estimate with certainty. Estimates of energy savings and operation and maintenance cost savings are based on more extensive assumptions that may be affected by numerous variables, making the estimates less reliable.

Because future events may not occur as anticipated in your assumptions, the IRR realized for the project may vary considerably from the estimate. In the face of this uncertainty, you should list explicit assumptions that underlie the cash flow estimates and reach agreement with other staff members that these assumptions are reasonable, particularly those about basic operating conditions and future energy prices. ☆

Steps in the Analysis

Now that we have introduced basic financial analysis concepts and tools, it's time to apply them to an energy-efficiency project. The following framework provides for a logical, systematic analysis of energy-efficiency options that should be applied to projects within each of the five stages of a comprehensive EPA ENERGY STAR Buildings upgrade. Consistent with the EPA ENERGY STAR Buildings Memorandum of Understanding (MOU) requirements, this framework seeks to maximize energy efficiency of a package of upgrades while maintaining profitability and minimizing first cost.

1. Choose hurdle rate criteria. The MOU states a hurdle rate of 20% IRR for projects with an assumed life of 10 years.
2. Convert hurdle rate to 4.2 year simple payback.[1] This conversion allows you to evaluate projects using the simple payback calculation instead of the more complex IRR equation.
3. Organize upgrade options into five groups following EPA's five stages.[2]
4. For each group, list the upgrade options by first cost in ascending order.

5. Prepare a cash flow analysis for each option.
6. Develop a package of options that passes the profitability test. Start by combining all options into a package to see if the combined package exceeds the hurdle rate. If the whole package passes, then you are done. If not, drop out options starting with the highest first cost option at the bottom of the list, recalculate the payback, and determine if the new package exceeds the hurdle rate. If it does not, continue dropping options from the bottom of the list until the package exceeds the hurdle rate. ☆

Business Analysis Example

List Energy-Efficiency Options After an Energy Audit

The first step in generating potential energy-efficiency options is an energy audit. The audit typically produces a listing of projects with their implementation cost. For example, Worksheet 1 lists five potential lighting efficiency options, sorted by first cost in ascending order, that were listed on an energy audit report. Life spans of all options are estimated at 10 years for planning purposes, which corresponds to the guidelines in the EPA ENERGY STAR Buildings MOU.

Prepare Cash Flow Analysis

Prepare cash flow estimates. Each option generally has a first cost and a stream of cost savings over its life span. In most cases, a very simple cash flow analysis is adequate.

To prepare a cash flow analysis, complete a table similar to the one shown in Worksheet 2. (For illustration purposes we provide only the LED Exit Signs worksheet; you should fill out a worksheet for each of the potential energy-efficiency options suggested by the audit.) In year zero, fill in the installation cost estimate. For the exit signs, this cost is $3,250. In the unusual case where the retrofit is planned over multiple years, provide an estimate of the cost for each year in which the work will be completed. Be sure to document the projected schedule in the list of key assumptions.

Fill in the energy cost savings projections for each year. The energy audit report typically converts the energy and demand savings into monetary savings based on the current energy rates. The amount of annual energy and demand cost savings for the exit signs reported on the energy audit report is $2,181. These savings are based on current operating schedules and energy rates. If you anticipate energy price changes, you may want to adjust the savings in future years. Also, if it is a multiyear project, you will need to phase in the energy savings over the first few

Worksheet 1: Listing of Potential Options from the Energy Audit Report

Stage 1: Green Lights Options	First Cost	Life Span (years)
1. Install LED Exit Signs	$3,250	10
2. Improve Corridor Lighting	$9,490	10
3. Install Occupancy Sensors	$22,200	10
4. Improve Private Office Lighting	$57,605	10
5. Install Daylighting Controls	$59,080	10

[1] 20% IRR over 10 years. Assumes single payment in year zero followed by equal savings each year after.

[2] Stage 1 – Green Lights, Stage 2 – Tune-up and Energy Auditing, Stage 3 – Load Reductions, Stage 4 – Fan Systems, Stage 5 – Heating and Cooling Plant Upgrades.

years as appropriate. Be sure to document the energy rates that are used for the calculation and the planned operating schedules in the list of key assumptions. In this example, the energy prices and operating schedules will remain constant over the 10-year life of the equipment.

Estimate the annual savings in maintenance costs. If you are replacing incandescent exit signs with LED signs, you can realize substantial savings in labor and materials over the life of the equipment. In the example, the expected maintenance savings equal $200 per year. In some cases, the energy-efficient retrofit requires more maintenance than the replaced equipment. If so, your maintenance savings entry should be negative. Document all key assumptions regarding maintenance savings.

Provide qualitative guidance. Additional savings or costs can be difficult to quantify. Potential savings that resist measurement include gains in worker productivity, increased sales attributable to the upgrade, and enhanced corporate image. Omitted savings/costs should simply be classified as having a negative, neutral, or positive influence on the net annual cash flow. For all five of the lighting options in the example, omitted costs/savings are neutral, even though evidence suggests that office lighting retrofits will increase worker productivity.

Classifying the risk level of the project can also be difficult. Anticipated cash flows may not be realized because of uncertainty about future events, such as the price of electricity in the year 2003. Compared with other investments that a company makes, such as new product development, energy-efficiency projects are considered low risk. Since you may not know the risk levels of other investments that your company is considering, you may want to classify energy-efficiency investments as risk neutral just to be safe.

Cash flow analyses for most options will follow this simple example, where the initial cost occurs in year zero, savings estimates are constant over a 10-year life, and risk and omitted cost/savings are neutral.

Worksheet 2: Cash Flow Analysis for LED Exit Signs

Year	Retrofit Cost	Energy & Demand Savings	Maintenance Savings	Omitted Savings	Risk Level
0	$3,250	$ 0	$ 0	Neutral	Neutral
1	0	2,181	200		
2	0	2,181	200		
3	0	2,181	200		
4	0	2,181	200		
5	0	2,181	200		
6	0	2,181	200		
7	0	2,181	200		
8	0	2,181	200		
9	0	2,181	200		
10	0	2,181	200		

Key Assumptions:

1. Retrofit will be completed in 3 months.
2. LED exit signs have a 10-year life expectancy.
3. Energy savings are based on the current average energy rate of $0.078/kWh.
4. No changes in energy rates over the 10-year period.
5. Maintenance savings are realized because lamps are changed less frequently.

In the example, cash flows for all five of the Stage 1 lighting options were evaluated using this simple framework.

Develop a package that passes the profitability test

If all options have single-payment first costs, cash flows that are uniform during the entire time horizon, and equal length life spans (usually 10 years), you can easily develop the options package with just a Payback/IRR table and calculator. If any of the options violate these assumptions, then you will need to calculate IRR directly. In the example, as in most cases you will encounter, these three assumptions hold for all options.

Start by listing the results from your cash flow analyses in Worksheet 3. List the options by first cost in ascending order, and then total the first cost and the annual net cash flow columns. Calculate the payback for the total package by dividing the first cost by the net annual cash flow.

In the example, a payback of 4.4 years ($151,625 in total first cost divided by a total annual net cash flow of $34,729) and a time horizon of 10 years generates an IRR of 18.6 percent, which falls below the hurdle rate of 20 percent. The total package does not pass the profitability test.

Continue by deleting Option 5—the option that has the most expensive first cost—from the package. Payback is now calculated as 3.3 years for the remaining four options ($92,545 in first cost divided by $28,285 in net annual cash flow). A payback of 3.3 years with a time horizon of 10 years yields an IRR of 27.7 percent, which exceeds the hurdle rate of 20 percent. The winning package should include all options except Option 5.

If the assumptions of a single payment, equal length time horizons, or uniform cash flows are untrue for any option, then you will need a financial calculator or spreadsheet software to compute IRR. (Note: Free software is available from EPA to perform these calculations, and most popular spreadsheet packages include IRR financial functions.) Simply enter the total combined net cash flows for each year and compare the calculated IRR with the hurdle rate. If the IRR is below the hurdle rate, then delete the next most expensive option from the package, respecify the cash flows, and compute the IRR. Continue this procedure until the IRR clears the hurdle rate. ☆

Worksheet 3: Developing a Winning Package

Stage 1: Green Lights Options	First Cost	Annual Net Cash Flow	Life Span (years)	Omitted Savings	Risk Category
1. Install LED Exit Signs	$3,250	$2,381	10	Neutral	Neutral
2. Improve Corridor Lighting	$9,490	$3,725	10	Neutral	Neutral
3. Install Occupancy Sensors	$22,200	$4,147	10	Neutral	Neutral
4. Improve Private Office Lighting	$57,605	$18,032	10	Neutral	Neutral
5. Install Daylighting Controls	$59,080	$6,444	10	Neutral	Neutral
Total Package	$151,625	$34,729	10	Neutral	Neutral

Stage 1 Winning Package	Package Payback	Package IRR	Pass 20% Hurdle		
All Options	4.4 years	18.6%	NO	Neutral	Neutral
Options 1–4	3.3 years	27.7%	YES	Neutral	Neutral

Other Considerations

The information provided by payback and IRR enables you to evaluate the profitability of the package. Remember that these financial calculations are based on the key assumptions. If any of your assumptions change, then you will want to analyze all of the options again before going forward with a proposed package of options.

Another important factor that may affect the accept/reject decision is the manner in which the project is financed. Financing options affect the balance sheet in different ways and can be a determining factor on whether to accept an investment proposal. See *Financing Your Energy-Efficiency Upgrade* (EPA 430-B-97-003) for more information on leasing, loans, and performance contracting. ☆

Calculating IRR and NPV Using Spreadsheets

A variety of spreadsheet programs calculate IRR and NPV using @ functions. The formulae for three of these programs are identified below. For lighting upgrade calculations, the rate used in each formula is the *discount rate*, and the range/block/values used are *expected cash flows*. When calculating IRR, you must have at least one negative value (representing the initial investment). For all three formulae, guess represents your best estimate of the IRR. If your estimate is not within an acceptable range, you will receive an error message.

- Lotus 1-2-3™

  IRR = @IRR(guess, range)
  NPV = @NPV(interest, range)

- Excel™

  IRR = @IRR(values, guess)
  NPV = @NPV(rate, values)

- Quattro Pro™

  IRR = @IRR(guess, block)
  NPV = @NPV(rate, block)

ENERGY STAR Buildings Tools

EPA offers the following software tools to assist in analyzing the economic and energy impacts of your upgrades.

QuikFan:	Analyzes upgrades to variable air volume systems with variable speed drives, high efficiency motors, and static pressure resets.
QuikChill:	Simulates the performance of centrifugal chiller plants to analyze chiller retrofit and replacement upgrades.
QuikPlan:	Helps plan, organize, and track the long-term financial and energy effects of projects within multiple facilities.
ProjectKalc:	Analyzes the upgrade costs, energy, demand, and maintenance savings of user-specified lighting upgrade solutions on both a fixture-specific and project-wide basis.

For More Information:

To learn more about EPA's ENERGY STAR Buildings Program, call the ENERGY STAR Hotline at 888–STAR–YES.

To order related publications call 888–STAR–YES or fax your request to 202–775–6680.

Visit our Web site at: http://www.epa.gov/buildings.html

Publication:	Reference Number:
• Introducing Your Company's Newest Profit Center—Energy Optimization	54009
• Financing Your Energy-Efficiency Upgrade	54009A
• Increasing Productivity Through Energy-Efficient Design	58215
• Questions and Answers: ENERGY STAR Buildings	28210
• ENERGY STAR Buildings Case Study Pack	19210

Appendix: Project IRR After Simple Payback

Payback (years)	Time Horizon (years)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.0	0.0%	61.8%	83.9%	92.8%	96.6%	98.4%	99.2%	99.6%	99.8%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%
1.5		21.5%	44.6%	55.2%	60.4%	63.1%	64.6%	65.5%	66.0%	66.3%	66.4%	66.5%	66.6%	66.6%	66.6%
2.0		0.0%	23.4%	34.9%	41.0%	44.5%	46.6%	47.8%	48.6%	49.1%	49.4%	49.6%	49.7%	49.8%	49.9%
2.5			9.7%	21.9%	28.6%	32.7%	35.1%	36.7%	37.8%	38.5%	38.9%	39.2%	39.5%	39.6%	39.7%
3.0			0.0%	12.6%	19.9%	24.3%	27.1%	29.0%	30.2%	31.1%	31.7%	32.2%	32.5%	32.7%	32.9%
3.5				5.6%	13.2%	18.0%	21.1%	23.2%	24.6%	25.7%	26.4%	26.9%	27.3%	27.6%	27.9%
4.0				0.0%	7.9%	13.0%	16.3%	18.6%	20.2%	21.4%	22.3%	22.9%	23.4%	23.7%	24.0%
4.5					3.6%	8.9%	12.4%	14.9%	16.7%	18.0%	18.9%	19.6%	20.2%	20.6%	20.9%
5.0					0.0%	5.5%	9.2%	11.8%	13.7%	15.1%	16.1%	16.9%	17.6%	18.0%	18.4%
5.5						2.5%	6.4%	9.2%	11.2%	12.7%	13.8%	14.7%	15.3%	15.9%	16.3%
6.0						0.0%	4.0%	6.9%	9.0%	10.6%	11.8%	12.7%	13.4%	14.0%	14.5%
6.5							1.9%	4.9%	7.1%	8.7%	10.0%	11.0%	11.8%	12.4%	12.9%
7.0							0.0%	3.1%	5.3%	7.1%	8.4%	9.5%	10.3%	11.0%	11.5%
7.5								1.5%	3.8%	5.6%	7.0%	8.1%	9.0%	9.7%	10.2%
8.0								0.0%	2.4%	4.3%	5.7%	6.9%	7.8%	8.5%	9.1%
8.5									1.2%	3.1%	4.6%	5.7%	6.7%	7.5%	8.1%
9.0									0.0%	2.0%	3.5%	4.7%	5.7%	6.5%	7.2%
9.5										0.9%	2.5%	3.8%	4.8%	5.6%	6.3%
10.0										0.0%	1.6%	2.9%	4.0%	4.8%	5.6%